SIMPLE MACHINES

TIME: 1HR **MARKS: 40**

SECTION I

[***All*** *questions are compulsory*]

Question 1: **[5]**

[i] Single movable pulley is considered as a modified form of.....

[a] class I lever

[b] class II lever

[c] class III lever

[d] none of the above.

[ii] Efficiency of an ideal machine is.....

[a] Mechanical advantage / velocity ratio

[b] Mechanical advantage x velocity ratio

[c] equal to one

[d] both a and c.

[iii] Which class of lever has Mechanical advantage and velocity ratio always less than one?

[a] class III

[b] class I

[c] class II

[d] none of the above

[iv] Calculate the work done by effort when a load of 60kgf is lifted through 20m by applying an effort of 30kgf which is displaced through 60m using a block and tackle system with velocity ratio 3.

[a] 120J

[b] 1200J

[c] 180J

[d] 18000J

[v] Which type of lever is present in the diving board of swimming pool?

[a] cantilever

[b] class I

[c] class II

[d] both a and c

Question 2: **[5]**

[i] In case of a practical machine work input is …. [less **/** **more**] than work output.

[ii] In ……. [class I / **class II** / class III] M.A always more than one.

[iii] Single fixed pulley is a modified form of …. [**class I** / class II] lever.

[iv] An example of a simple machine that brings about transformation of energy is…… [**sugarcane juice extractor** / lever / pulley]

[v] Velocity ratio is the ratio of two ………. [dissimilar / **similar**] quantities hence a pure ratio and unitless quantity.

Question 3:

[a] State the class of levers and the relative position of load, fulcrum, and effort in each of the following cases:

[i] bottle opener [ii] Sugar tongs. **2**

Ans:

Bottle opener: Class II lever [load is between fulcrum and effort].

Sugar tongs: Class III lever [Effort is between fulcrum and load].

[b] Levers of class III cannot lift heavier loads. Why? **2**

Ans: Levers of class III have the effort in between fulcrum and load so their mechanical advantage is less than one as effort arm is smaller than load arm. Hence more effort is required to lift heavier loads thus inconvenient.

[c] A boy uses a single pulley to lift a load of 50kgf to some height. Another boy uses a single movable pulley to lift the same load to the same height. Compare the effort applied by them? **2**

Ans: Effort applied in single movable pulley is half the effort applied in case of single fixed pulley.

d] A machine is 80% efficient. What does it mean? **2**

Ans: A machine is 80% efficient means that 80% of work input is utilized in giving output work and 20% is wasted in the form of frictional resistance and work done in overcoming the weight of the machine parts.

e] What is the M.A of class III lever and give any one application of the same. **2**

Ans: The M.A of class III lever is always less than 1. For example tweezers where effort is applied between load and fulcrum.

<u>SECTION II</u>

[*Attempt any **two** questions out of three*]

Question 4:

a] With reference to the terms mechanical advantage, velocity ratio and efficiency of a machine, name the term that will not change for a given design **3**

Ans: Velocity ratio is the quantity which would not change for a given design of the machine. It would only change if design changes as displacement of effort and load would vary.

b] Prove that efficiency of a machine is the ratio of mechanical advantage to the velocity ratio of the machine. **4**

Ans: Efficiency of machine = work output / work input

= load x displacement of load / effort x displacement of effort

= [load / effort] x [d_{effort} / d_{load}]

= M.A / V.R

c] A pulley system has a velocity ratio of 4 and an efficiency of 90%. Calculate [i] Mechanical advantage of the system [ii] Effort required to raise a load of 300N by the system **3**

Ans: Percentage efficiency = [M.A / V.R] x 100

90 = [M.A / 4] x 100

M.A = 3.6

Now, Mechanical advantage = Load / effort

3.6 = 300 / effort

Effort = [300 / 3.6]

= 83.33 N

Question 5:

a] A pulley system has a velocity ratio equal to 4 is used to lift a load of 150 kgf through a vertical height of 20m. The effort required is 50kgf in the downward direction. Calculate:

[i] Distance moved by effort

[ii] Work done by effort

[iii] The mechanical advantage of the pulley system

[iv] The efficiency of pulley system [g = 10Nkg^{-1}] **4**

Ans:

[i] Velocity ratio for block and tackle

= displacement of effort/displacement of load

Hence, 4 = [displacement of effort / 20]

Displacement of effort = [20 x 4]

= 80m

[ii] Work done by effort = effort x displacement of effort

= [50 x 10 x 80]

= 40000J

[iii] Mechanical advantage = load / effort

= [150 x 10 / 50 x 10]

= 3.

[iv] percentage efficiency = [M.A / V.R] x 100

= [3 / 4] x 100

= 75%.

b] Draw a neat labelled diagram of block and tackle system of pulleys having velocity ratio 4. **3**

c] State the factors on account of which the efficiency of a practical machine is always less than 100%. **3**

Ans: Factors on account of which the efficiency of a practical machine is less than 100% are:

[i] Frictional resistance

[ii] Weight of the movable machine parts

[iii] Elasticity of the string.

Question 6:

a] A cook uses a fire tong of length 28cm to lift a piece of burning coal of mass 250g. If he applies a force at 0.7m from the fulcrum find the force applied by the cook in SI unit. [g = $10ms^{-2}$] **4**

Ans: A fire tong is an example of class III lever. Effort is between load and fulcrum.

Applying the principle of levers,

For the lever to be in rotational equilibrium,

Load x load arm	**=**	**Effort x Effort arm**
[250/1000] x 10 x [28/100]	**=**	**[Effort x 10] x 0.7**
Effort	**=**	**0.1N**

b] A crowbar of length 150cm has its fulcrum at 25 cm from the load. Calculate the Mechanical advantage of the crowbar. **3**

Ans: Since the load is at 25cm from fulcrum the load arm distance is 25cm. Total length of crowbar is 150cm. Hence the effort arm distance is [150 – 25] = 125cm.

Now,

Mechanical advantage	**=**	**Effort arm / load arm**
	=	**[125 /25]**
	=	**5**

c] State three ways of minimizing the losses in a machine. **3**

Ans: Three ways of minimizing the losses in a machine are:

[i] Lubricating the machine parts

[ii] reducing the weight of the movable machine parts

[iii] using a string with greater elasticity.

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